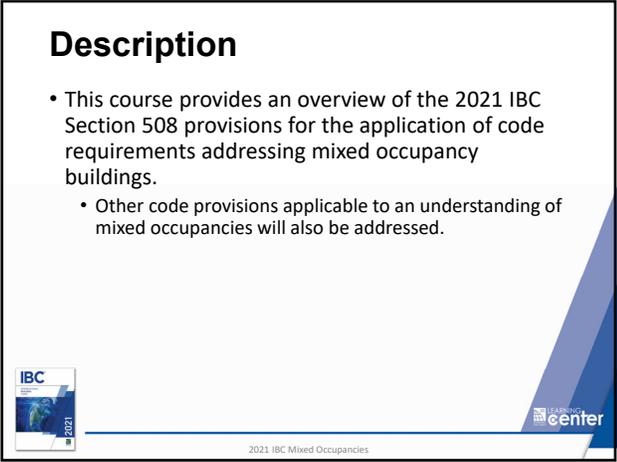
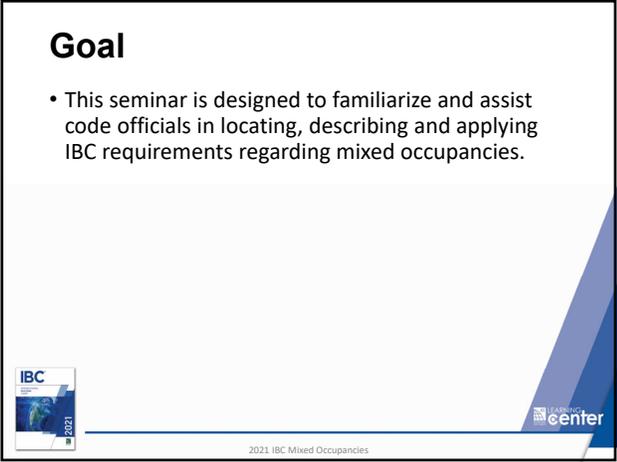




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3

Objectives

After completing this seminar, you will be able to:

- Define the concept for addressing mixed-occupancy buildings.
- Identify and apply the three options that are available for regulating mixed-occupancy buildings.
- Describe the relationship of occupancy classification, allowable height, allowable area and occupancy separation to mixed-occupancy buildings.
- Identify incidental uses and understand how they differ from mixed-occupancy conditions.




2021 IBC Mixed Occupancies

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Course Overview

- Module 1 – Concept of Mixed Occupancies
- Module 2 – Occupancy Classification
- Module 3 – Incidental Uses
- Module 4 – Foundations of the IBC for Mixed Occupancies
- Module 5 – Application of the Mixed Occupancy Methods
- Module 6 – Nonseparated Occupancies
- Module 7 – Separated Occupancies
- Module 8 – Accessory Occupancies
- Module 9 – Allowable Height and Area for Multistory Buildings
- Module 10 – Miscellaneous Applications




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Concept of Mixed Occupancies

Module 1




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Definition

- A mixed-occupancy condition occurs where two or more distinct occupancy classifications are determined to exist in the same building.
- Under such circumstances, the designer has available several different methodologies in Section 508 to address the mixed-occupancy building.
- Compliance with at least one of the methods is mandatory.




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Mixed Use and Occupancy Scope

- The provisions of Section 508 address specific mixed-occupancy requirements that are to be applied in addition to the applicable provisions established throughout the IBC.
- The provisions of Section 509 address incidental uses as identified in Table 509.
- There is no relationship between the mixed-occupancy provisions of Section 508 and those addressing incidental uses in Section 509.
 - It is important to identify the scope of each of the two concepts in order to recognize the differences in their applications.




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Use vs. Occupancy

- “Use” and “Occupancy” are terms that differ in meaning and application within the IBC.
- “Use” describes the activity that occurs within the space, room or building.
 - “Use” is seldom utilized in the IBC as the scoping mechanism.
 - Examples include occupant load calculation and incidental uses.
- “Occupancy” describes the specific classification a “use” is assigned when applying the code to a space, room or building.
 - Almost all code provisions with application to a limited number of situations are regulated by “Occupancy”.
 - Primary examples include allowable height and area, fire protection features and means of egress requirements.




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**General Provisions
Section 508.1**

- Three options established in Section 508 to address mixed-occupancy buildings include:
 - Accessory Occupancies.
 - Nonseparated Occupancies.
 - Separated Occupancies.
- Methods for determining maximum allowable size, height and area and separations are identified for each option.
- One of the three options must be applied to a mixed-occupancy condition.




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**General Provisions
Section 508.1**

- Occupancy Classification
 - Proper occupancy classifications determined - Section 302.
 - Two or more different occupancies - Section 508.
- Allowable Building Height and Area
 - Final analysis for allowable building height and area cannot be done until one of the three mixed-occupancy options has been chosen.
- Fire Protection Features
 - Required extent of fire protection coverage of building differs among the three mixed occupancy methods.
- Separation
 - Separation is not required between occupancies; or
 - Some degree of fire-resistance-rated separation is mandated to isolate one occupancy from another.




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Occupancy Classification

Module 2




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**Classification of Occupancies
Section 302**

- Classification is essential to the proper application of the IBC.
- Structure to be classified according to the function or functions for which it is intended.
- Buildings to be classified prior to the application of Section 508 regulating mixed-occupancy conditions.




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**Classification of Occupancies
Section 302**

- Chapter 3 provides an extensive listing of various uses and their corresponding occupancy classifications.
- There are many special cases and exceptions.
- Unsure of classification? Ask for more information.
- If two or more distinct occupancy groups are present, the provisions of Section 508 will apply.




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**General Provisions
Section 302.1**

- Structures are classified into one or more occupancies in accordance with their intended uses.
- If the use is not specifically identified in Chapter 3, it must be classified with the occupancy it most nearly resembles.




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Occupancy Groups Chapter 3

A	Assembly	Section 303
B	Business	Section 304
E	Educational	Section 305
F	Factory and Industrial	Section 306
H	High-hazard	Section 307
I	Institutional	Section 308
M	Mercantile	Section 309
R	Residential	Section 310
S	Storage	Section 311
U	Utility and Miscellaneous	Section 312

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Occupancy Classification Overview

- Multiple uses do not necessarily create multiple occupancies.
- General occupancy classification is intended to include related support areas such as corridors, stairways, restrooms, mechanical equipment rooms, small storage areas, etc.
- Support areas of higher hazard are often regulated as incidental uses.

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Incidental Uses

Module 3

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**Incidental Uses
Section 509**

- Rooms or spaces that pose risks which aren't addressed by the provisions specific to a general occupancy group:
 - Presence of combustible or hazardous material.
 - Presence of a hazardous activity or equipment.
- Limited to those found in Table 509.1.
- Regulated according to their hazard level.
- Regulated as part of primary occupancy.
- Not regulated as accessory occupancy.
- Not regulated under mixed occupancy provisions.
- Limited to 10% of area of story in which located.




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**Incidental Uses
Identification**

Uses are those listed in Table 509.1, including:

- Furnace rooms where any piece of equipment exceeds a 400,000-Btu per hour input rating.
- Paint shops (where located in other than a Group F occupancy, and not when Group H occupancy).
- Laboratories in Group E occupancies.
- Vocational shops located in Group E occupancies.
- Laundry rooms over 100 square feet.
- Physical plant maintenance shops in Group I-2 occupancies.




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Incidental Uses Classification

- Occupancy classification is consistent with the general classification of the area of the building in which the incidental use is located.
 - A refrigerant machinery room in a manufacturing building. Classified as Group E occupancy.
 - A physical plant maintenance shop in a hospital. Classified as Group I-2 occupancy.




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Incidental Uses Classification

The diagram illustrates two scenarios for incidental use classification. In the first, a 'Group E Chemistry Classroom' is shown as a shaded area within a larger 'Group E High School' footprint. A label points to the classroom with the text 'Separated or Protected Per Table 509.1'. In the second, a '220 square feet Group R-1 Laundry Room' is shown as a shaded area within a larger 'Group R-1 Hotel' footprint. A label points to the laundry room with the text 'Separated or Protected Per Table 509.1'. The IBC 2021 logo and 'LEARNING center' logo are visible at the bottom of the slide.

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Incidental Uses Separation and Protection

- Intent is to isolate incidental use hazard from remainder of building, typically through use of:
 - Fire-resistance-rated separation; or
 - Smoke-resistant separation plus sprinkler system.
- Under certain conditions, sprinkler option cannot be substituted for fire-resistance-rated separation.
- Both fire-resistance-rated separation and automatic sprinkler system protection are mandated in limited cases.

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Incidental Uses: Separation and Protection

The diagram shows two examples of separation and protection for incidental uses. The first example shows a 'Group F-1 Factory' with an 'Incinerator Room' shaded as an incidental use. Labels indicate it is 'Protected by automatic sprinkler system' and has a 'Minimum 2-hour fire barrier'. The second example shows a 'Group I-2 Nursing Home' with a 'Physical Plant Maintenance Shop' shaded as an incidental use. Labels indicate it has a 'Minimum 1-hour fire barrier'. The IBC 2021 logo and 'LEARNING center' logo are visible at the bottom of the slide.

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Protection Section 509.4.2

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Foundations of the IBC for Mixed Occupancies

Module 4

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Application of Mixed-Occupancy Provisions

- Proper application of mixed-occupancy provisions rely on full understanding of:
 - Occupancy classification (Chapter 3).
 - Allowable building height (Chapter 5).
 - Allowable building area (Chapter 5).
 - Fire protection features (Chapter 9).
 - Construction of fire-resistant separations (Chapter 7).

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**Occupancy Classification
Chapter 3**

- As previously addressed, occupancy classification is first required.
- Mixed-occupancy conditions occur where two or more distinct occupancy classifications occur in a building.
- Occupancy classification for all three mixed-occupancy methods is based on individual classification per Section 302.1.




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**Building Heights and Areas
Chapter 5**

- Chapter 5 provides basic limits for each building:
 - Maximum height.
 - Maximum number of stories.
 - Allowable area.
- Limits are set according to type of construction and the occupancy.
 - Tables 504.3, 504.4 and 506.2.
 - Allowable increases.
- Allowable height and area cannot be determined until choice of mixed occupancy method is made.




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**Fire Protection Features
Chapter 9**

- Chapter 9 identifies where automatic sprinkler systems, fire alarm systems and other fire protection features are required.
- Such systems are typically required based on occupancy classification, with thresholds selectively established based on:
 - Floor area
 - Occupant load
 - Location within building




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Fire-resistance-rated Separations Scope

- Section 508 specifies requirements.
- Not required for:
 - Accessory occupancies.
 - Nonseparated occupancies.
 - Certain combinations under separated occupancies.
- Required for:
 - Group H occupancies in mixed-occupancy buildings.
 - Certain combinations under separated occupancies as specified in Table 508.4.




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Fire Barriers/Horizontal Assemblies Sections 707 and 711

- Separations, where required, must be:
 - Fire barriers constructed in accordance with Section 707. Provisions of Section 707 address:
 - Continuity.
 - Openings.
 - Penetrations.
 - Joints.
 - Ducts and air transfer openings.
 - Supporting construction.
 - Horizontal assemblies constructed in accordance with Section 711.




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Application of the Mixed Occupancy Methods

Module 5




2021 IBC Mixed Occupancies

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Mixed Occupancies: Overview Section 508.1

- There are five key components that regulate mixed-occupancy buildings:
 - Occupancy classification.
 - Fire protection systems.
 - Allowable height.
 - Allowable area.
 - Fire-resistive separation.
- The three mixed-occupancy options differ from each other based on one or more of these five components.




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Application of Three Options Section 508.1

- Section 508.1 mandates that one of the three options must be applied where a mixed occupancy exists.
 - Determination of the option depends on owner/designer decisions.
 - Building function.
 - Construction costs.
 - Design flexibility.
 - Compliance with at least one of the three options to be verified by building official.

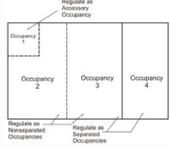



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Use of Multiple Options Section 508.1

- Owner/designer may choose to use more than one option within same building.
- Nonseparated occupancies: aggregate area of nonseparated occupancies evaluated as single hazard
- Separated occupancies option: relationship between multiple pairs of adjacent occupancies to be individually analyzed
- Accessory occupancies option: limit on accessory occupancies viewed on a story-by-story basis





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Conditions Where Not Applicable Section 508.1, Exceptions

- There are two conditions under which the provisions of Section 508 do not apply:
 - Occupancies regulated under the special provisions height and area provisions of Section 510.
 - Group H-1, H-2 and H-3 occupancies where required to be in a detached building by Table 415.6.5.




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Nonseparated Occupancies

Module 6




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Nonseparated Occupancies Overview

- “Nonseparated occupancies” method considers most restrictive requirements for fire protection and allowable height/area for occupancies involved
- This method beneficial to designer due to:
 - No requirement to separate occupancies
 - Flexibility allowed by application of “worst-case” approach to fire protection and building size.
- No requirements for a fire-resistance-rated separation between adjacent occupancies.
- Nonseparated occupancies method is most common of methods utilized.




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Nonseparated Occupancies Section 508.3

No physical or fire-resistive separation required.

Occupancy 1 Occupancy 2

- Minimum type of construction based upon the most restrictive allowable heights and areas of Occupancies 1 and 2.
- Most restrictive fire protection requirements of Chapter 9 for Occupancies 1 and 2 applied to entire building.

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Nonseparated Occupancies: Classifications – Section 508.3.1

- Occupancy classification based on the general provisions of Section 302.1.
- Individually classified based on the occupancy of each individual space.

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Nonseparated Occupancies: Fire Protection – Section 508.3.1

- Most restrictive applicable provisions of Chapter 9 regulating fire-protection systems apply to the total nonseparated occupancy area, not just the specific individual occupancy, and typically address:
 - Automatic sprinkler systems.
 - Fire alarm systems.

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Nonseparated Occupancies: Fire Protection – Section 508.3.1

Example

Group B Office Suite
5,000 sq. ft.

Group E Day Care Facility
3,000 sq. ft.

• Manual fire alarm system required in Group E occupancy by Section 907.2.3 required throughout entire building.

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Nonseparated Occupancies: Allowable Area and Height – Section 508.3.2

- The maximum allowable height and area of building is based on the most restrictive allowances for the occupancy groups under consideration.
- The most restrictive allowable area is applied to the entire building.
- Same limitation is applied to the building's height.

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Nonseparated Occupancies: Allowable Area and Height – Section 508.3.2

Example: Building is to be multistory, fully sprinklered and of Type VB construction. Frontage increase of 30 percent available. 1st story contains Group M and A-2 occupancies as shown with Group B occupancy above.

Group M Sales Tenant

Group A-2 Restaurant

Regulated as Nonseparated Occupancies

For SI: 1 square foot = 0.0929 m².

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Nonseparated Occupancies: Allowable Area and Height – Section 508.3.2

	Group M	Group A-2	Group B
Allowable Area (square feet)	29,700	19,800	29,700
Allowable Height (number of stories)	2	2	3

Result: Building is limited to 2 stories and 19,800 sf per story to comply with Nonseparated Occupancies method



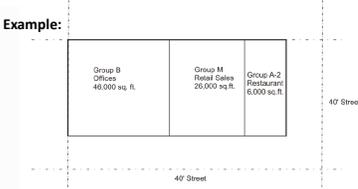

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Nonseparated Occupancies Example: Allowable Area - Section 508.3.2

- Given:** A one-story, 78,000-square-foot, fully sprinklered building with three occupancy groups as shown. The building is of Type IIB construction and adjoins two public ways that qualify for a 50-percent frontage increase.

Example:



- Determine:** Does the building comply with the area limitations based on nonseparated occupancies?




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Nonseparated Occupancies Example: Allowable Area - Section 508.3.2

- Allowable building area to be based on the most restrictive allowances for the occupancy groups under consideration based on the building's type of construction:
 - Group A-2 $38,000 + 4,750 = 42,750$ sf
 - Group B $92,000 + 11,500 = 103,500$ sf
 - Group M $50,000 + 6,250 = 56,250$ sf
- Therefore, the building does not comply for "nonseparated occupancies" because actual area (78,000 sf) exceeds most restrictive allowable area (42,750 sf).




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Nonseparated Occupancies: Separations - Section 508.3.3

- Application of this option will result in no physical or fire-resistance-rated separation between the nonseparated occupancies.

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Nonseparated Occupancies Section 508.3.3, Exceptions

- Group H-2, H-3, H-4 and H-5 occupancies must be separated from all other occupancies per Section 508.4 (separated occupancies).
- Group I-1, R-1, R-2 and R-3 dwelling units and sleeping units must be separated from each other and from all other occupancies contiguous to them per Section 420.

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Nonseparated Occupancies: A Four-Step Process

- Determine the occupancies present in the building.
- Apply the most restrictive fire protection requirements of Chapter 9 to the entire building.
- Determine the maximum allowable height and area for each occupancy. Apply the most restrictive to the entire building.
- Apply all other code requirements to each portion of the building based on the occupancy classification of that portion.

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Nonseparated Occupancies: Applying the Process

- Given:** A three-story, Type IIB building containing assembly, business and mercantile uses. The building is fully sprinklered and does not qualify for any frontage increase for allowable area purposes. Each story is 24,000 square feet in floor area.

- Determine:** Does the building comply with the nonseparated mixed occupancy option?

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Nonseparated Occupancies: Applying the Process

- Solution:**
 - Determine the occupancies in the building.
 - Group A-2
 - Group B
 - Group M
 - Apply the most restrictive fire protection requirements of Chapter 9 to the entire building.
 - Building to be fully sprinklered due to Group A-2 occupancy located above the level of exit discharge.
 - Building to be provided throughout with manual fire alarm system due to more than 100 persons in Group B above the level of exit discharge.

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Nonseparated Occupancies: Applying the Process

- Determine the maximum allowable height and area for each occupancy. Apply the most restrictive to the entire building.

	Group A-2	Group B	Group M
Allowable Height (number of stories)	3	4	3
Allowable Area per Story (square feet)	28,500	69,000	37,500
Allowable Building Area (square feet)	85,500	207,000	112,500

Building limited to:

- 3 stories
- 28,500 sf per story
- 85,500 sf per building

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Nonseparated Occupancies: Applying the Process

4. Apply all other code requirements to each portion of the building based on the occupancy classification of that portion.

Apply all other provisions based on the specific occupancy as applicable.

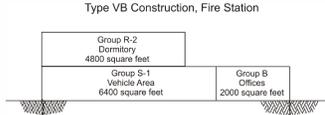



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Mixed Occupancies Exercise

- Given: A two-story district fire station contains Group B, R-2 and S-1 occupancies as shown. The building is fully sprinklered, constructed of Type VB construction and has open frontage allowing for a 75-percent area increase.



Determine: If the building can be constructed under the nonseparated occupancies provisions for mixed-occupancy buildings?




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Mixed Occupancies Exercise: Solution

Classify occupancies	Offices: Group B Dormitory: Group R-2 Vehicle area: Group S-1
Identify most restrictive fire protection features	Given: Fully sprinklered Fire alarms: R-2 – Manual fire alarm not required Smoke alarms required S-1 – No applicable requirements B – No applicable requirements




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Mixed Occupancies Exercise: Solution

Identify maximum allowable height	Given: Type VB construction – fully sprinklered R-2: 2 + 1 = 3 stories S-1: 1 + 1 = 2 stories B: 2 + 1 = 3 stories Most restrictive is Group S-1 at 2 stories
Identify maximum allowable area	Given: Type VB, fully-sprinklered, 75% frontage R-2: 26,250 sf S-1: 42,750 sf B: 42,750 sf Most restrictive is Group R-2 at 26,250 sf
Solution	Most restrictive provisions apply: S-1: 2 stories maximum -- complies R-2: 26,250 sf maximum floor area – complies Fully-sprinklered – complies Alarms – smoke alarms required Separation of R-2 from remainder of building by horizontal assembly required by Section 420

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Nonseparated Occupancies: Special Applications – Sections 508.3.1.1, 508.3.1.2

- Special provisions specific to the application of the 'nonseparated occupancies' method includes use in:
 - High-rise buildings
 - Group I-2, Condition 2 occupancies

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Nonseparated Occupancies: High-rise Buildings – Section 508.3.1.1

- Where nonseparated occupancies occur in a high-rise building, the most restrictive provisions of Section 403 that apply to the nonseparated occupancies to apply to the entire high-rise building.

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**Nonseparated Occupancies:
Group I-2, Condition 2 Occupancies –
Section 508.3.1.2**

- Where one of the nonseparated occupancies is Group I-2, Condition 2, the most restrictive provisions of the following sections shall apply throughout the fire area containing the Group I-2, Condition 2 occupancy:
 - Section 407 Group I-2
 - Section 509 Incidental uses
 - Section 712 Vertical openings
- Most restrictive egress provisions to apply to path from Group I-2, Condition 2 to the exit discharge



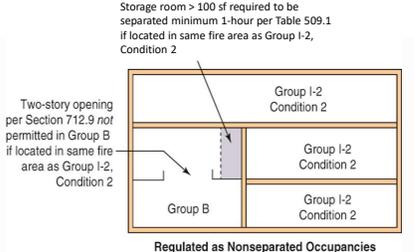

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**Nonseparated Occupancies:
Group I-2, Condition 2 Occupancies –
Section 508.3.1.2**

Storage room > 100 sf required to be separated minimum 1-hour per Table 509.1 if located in same fire area as Group I-2, Condition 2

Two-story opening per Section 712.9 not permitted in Group B if located in same fire area as Group I-2, Condition 2





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Separated Occupancies

Module 7




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Separated Occupancies Overview

- “Separated occupancies” method uses a balanced approach to regulating mixed occupancy conditions.
- This method is typically applied where nonseparated occupancies method is impractical, undesirable or unavailable.
- Separated occupancies method to be applied where Group H-2, H-3, H-4 and H-5 occupancies are present.
 - Group H-1 to be located in detached (single-occupancy) buildings not used for other purposes.



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Separated Occupancies Section 508.4

- Separated occupancies is the only one of the three options where a fire-resistance-rated occupancy separation is required under mixed-occupancy conditions.
- Table 508.4 is referenced to determine the degree of fire resistance that is mandated for separations.
- Separations may not be required where occupancies are considered to be of same level of hazard.



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Separated Occupancies Section 508.4.1

- This approach also differs from the other options regarding fire protection requirements:
 - The fire protection requirements of Chapter 9 are to be applied individually in each portion of the building based on the occupancies in each portion, however:
 - Where nonfire-barrier-separated occupancies are permitted by Table 508.4, the most restrictive provisions of Chapter 9 that apply to the separated occupancies shall apply to the total nonfire-barrier-separated occupancy areas.



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Separated Occupancies Example Section 508.4.1

EXAMPLE:
If 2nd story of Group B occupancy has an occupant load > 100, a manual fire alarm system is required in the Group B portion of the building by Section 907.2.2, #2.

Under separated occupancies, the fire alarm system shall be:

- Extended to the Group F-1 portion of the building, OR
- A fire area separation by a minimum 2-hour fire barrier shall be provided between the Group B and the Group F-1

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Separated Occupancies Section 508.4.1

- Where occupancy separations (fire barriers and/or horizontal assemblies) also define the limits of any fire areas as established in Chapter 9 for requiring an automatic sprinkler system, the provisions of Section 901.7 and Table 707.3.10 shall also comply.

**TABLE 707.3.10
FIRE-RESISTANCE RATING REQUIREMENTS FOR
FIRE BARRIERS, FIRE WALLS OR HORIZONTAL
ASSEMBLIES BETWEEN FIRE AREAS**

OCCUPANCY GROUP	FIRE-RESISTANCE RATING (hours)
H-1, H-2	4
F-1, H-3, S-1	3
A, B, E, F-2, H-4, H-5, I, M, R, S-2	2
U	1

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Separated Occupancies Sections 508.4.2, 508.4.3

- In addition, this approach differs from the other options regarding allowable height and area:
 - The allowable height for each occupancy within the building is based on Section 503.1, consistent with the method for single-occupancy buildings.
 - The allowable area of the building is based on the sum of the ratios where the actual floor area of each occupancy divided by the allowable floor area of each occupancy is not to exceed 1.0 (unity formula).

$$\frac{a_1}{A_1} + \frac{a_2}{A_2} + \frac{a_3}{A_3} + \dots \leq 1.0$$

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**Separated Occupancies:
Occupancy Classifications –
Section 508.4.1**

- This option requires that the occupancies be classified individually based on their specific functions.
- Requirements for means of egress, automatic sprinkler systems, fire alarm systems, plumbing facilities and all other provisions are to be applied individually to the various occupancies in the building.

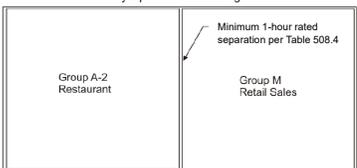



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**Separated Occupancies:
Occupancy Classifications -
Section 508.4.1**

Fully Sprinklered Building



- Group A-2 portion to be regulated by Group A-2 requirements.
- Group M portion to be regulated by Group M requirements.




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**Separated Occupancies:
Allowable Area - Section 508.4.2**

- When a mixed-occupancy building is regulated under the provisions of Section 508.4 for separated occupancies, the unity formula is used in the determination of allowable area.
- Compliance for allowable area can only be achieved where the sum of the ratios of actual floor area divided by allowable floor areas for each of the occupancies involved does not exceed 1.




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Separated Occupancies: Allowable Area - Section 508.4.2

- The formula can be expressed as:

$$\frac{a_1}{A_1} + \frac{a_2}{A_2} + \frac{a_3}{A_3} + \dots \leq 1.0$$

- a_1, a_2 and a_3 represent the actual floor areas for the individual occupancies.
- A_1, A_2 and A_3 represent the maximum allowable areas for the same respective occupancies.
- Calculation applied regardless of any required separation.
- Applicable frontage increase for entire building applied to each of the occupancies.
- Sprinkler increase applied on a "per occupancy" basis.




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Separated Occupancies: Allowable Area - Section 508.4.2

- Given:** A one-story, 78,000-square-foot, fully sprinklered building with three occupancy groups as shown. The building is of Type IIB construction and adjoins two public ways that qualify for a 50-percent frontage increase.
- Determine:** Does the building comply with the allowable area limitations based on separated occupancies?

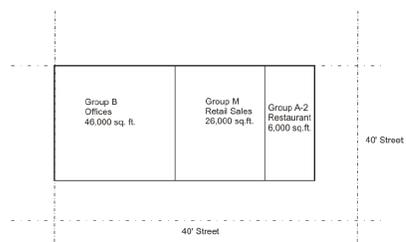
$$\frac{a_B}{A_B} + \frac{a_M}{A_M} + \frac{a_{A-2}}{A_{A-2}} \leq 1.0 ?$$



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Separated Occupancies: Allowable Area - Section 508.4.2



For SI: 1 square foot = 0.0929 m².




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Separated Occupancies: Allowable Area - Section 508.4.2

Solution: Apply the unity formula of Section 508.4.2 to determine compliance with allowable area.

Occupancy	Actual Area	Tabular Area Table 506.2	Allowable Area w/ Frontage Increase
Group A-2	6,000	38,000	42,750
Group B	46,000	92,000	103,500
Group M	26,000	50,000	56,250

$6,000/42,750 + 46,000/103,500 + 26,000/56,250 \leq 1.0$???
 $0.14 + 0.44 + 0.46 \leq 1.0$???
 1.04 is not ≤ 1.0 , therefore allowable area is exceeded.

What options are available to the designer to bring the building into compliance?




2021 IBC Mixed Occupancies

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Separated Occupancies: Allowable Height - Section 508.4.3

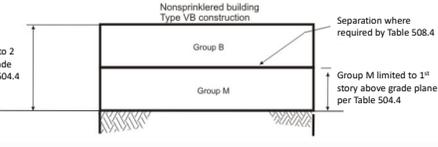
- Each individual occupancy in a multiple-story, mixed-occupancy building is regulated for height independently based on Section 503.1.
- Maximum number of stories for each occupancy is limited by the type of construction in Section 503.1.
 - Maximum height in feet is typically unaffected as it is most commonly based on construction type and sprinkler protection.
 - Does not vary based on occupancy classification
 - Where allowable height in feet varies among occupancies, each occupancy is also individually limited.




2021 IBC Mixed Occupancies

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Separated Occupancies: Allowable Height - Section 508.4.3





2021 IBC Mixed Occupancies

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Separated Occupancies: A Five-Step Process

1. Determine the various occupancies that occur within the building.
2. Determine the minimum required fire-resistance rating between adjacent occupancies.
3. Verify that the building does not exceed the maximum allowable area for the type of construction involved.
4. Verify that the locations of the occupancies do not exceed their maximum allowable height based on the building's type of construction.
5. Apply all other code requirements to each portion of the building based on the occupancy of that portion.



2021 IBC Mixed Occupancies

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Separated Occupancies: Applying the Process

- **Given:** A 30,000-square-foot, one-story building of Type VB construction contains offices, manufacturing operations and flammable gas storage rooms (Group H-2) as shown on the following slide. The building is fully sprinklered and qualifies for a 50-percent allowable area increase for frontage. There is no fire-resistant separation between the office area and the manufacturing area. 1-hour fire barriers separate the hazardous storage rooms from other areas of the building.

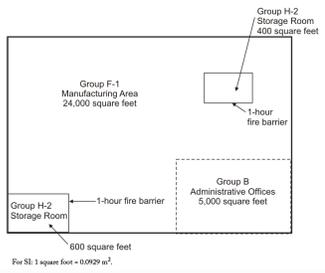


2021 IBC Mixed Occupancies

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Separated Occupancies: Applying the Process

- **Determine:** Does the building comply with the provisions for separated occupancies?



2021 IBC Mixed Occupancies

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Separated Occupancies: Applying the Process

- Solution:
 - Determine the various occupancies that occur within the building.

Offices	Group B
Manufacturing Area	Group F-1
Flammable Gas Storage Rooms	Group H-2
 - Determine the minimum required fire-resistance rating between adjacent occupancies.

F-1/H-2	2 hours (only 1-hour shown)
B/F-1	no separation required
B/H-2	not applicable




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Separated Occupancies: Applying the Process

- Verify that the building does not exceed the maximum allowable area for the type of construction involved.

$\frac{a_{F-1} + a_B + a_{H-2}}{A_{F-1} + A_B + A_{H-2}} \leq 1.0?$	
$a_{F-1} = 24,000$ $a_B = 5,000$ $a_{H-2} = 1,000$	$A_{H-2} = 3,000$ T506.2 $\pm 1,500$ Frontage $= 4,500$ Total Allowable
$A_{F-1} = 34,000$ T506.2 $\pm 4,250$ Frontage $= 38,250$ Total Allowable	$A_B = 36,000$ T506.2 $\pm 4,500$ Frontage $= 40,500$ Total Allowable
$\frac{24,000 + 5,000 + 1,000}{38,250 + 40,500 + 4,500} \leq 1.0?$	
$0.63 + 0.12 + 0.22 = 0.97 < 1.0$ OK	




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Separated Occupancies: Applying the Process

- Verify that the location of the occupancies do not exceed their maximum allowable height based on the building's type of construction.

All one-story buildings comply.
- Apply all other code requirements to each portion of the building based on the occupancy of that portion.

Applicable provisions to be applied based on the specific occupancy involved.




2021 IBC Mixed Occupancies

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Mixed Occupancies Practice

- Given:** A one-story, multiple-tenant retail center containing Group A-2, A-3, B and M occupancies as shown. The 52,000-square-foot building is fully sprinklered, of Type IIB construction and has adequate frontage for a 50-percent allowable area increase.




2021 IBC Mixed Occupancies

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Mixed Occupancies Practice

- Determine:** Does this building comply with Section 508.4 for separated occupancies?

Type IIB construction
Fully sprinklered, Retail Center

Group A-2 6,000 square feet				
	Group M 10,000 square feet	Group M 10,000 square feet	Group B 10,000 square feet	Group A-3 10,000 square feet
Group A-2 6,000 square feet				

For SI: 1 square foot = 0.0929 m².

One-hour fire barriers provide separation between all tenant spaces




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Mixed Occupancies Practice Solution

Minimum Occupancy Separation	Since building is fully sprinklered: A-2 /A-2 none required A-2 /M: 1-hour M/M: none required M/B: none required B/A-3 1-hour All OK
Allowable Height	Building is single story. OK
Allowable Area	A-2: 38,000 + 4,750 = 42,750 sf A-3: same as A-2 B: 92,000 + 11,500 = 103,500 sf M: 50,000 + 6,250 = 56,250 sf $12,000/42,750 + 10,000/42,750 + 10,000/103,500 + 20,000/56,250 \leq 1$ $0.28 + 0.23 + 0.10 + 0.36 = 0.97$ OK

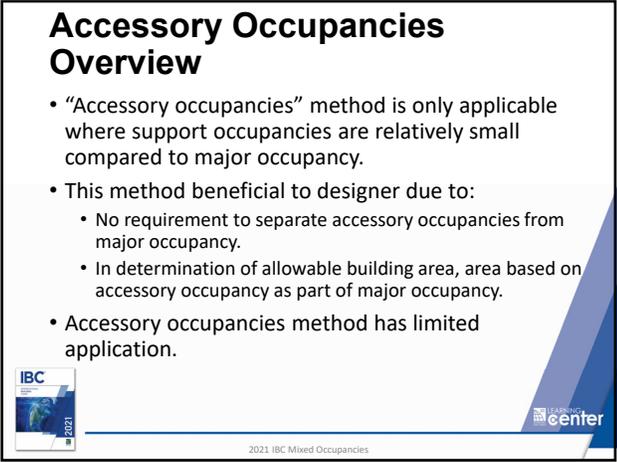



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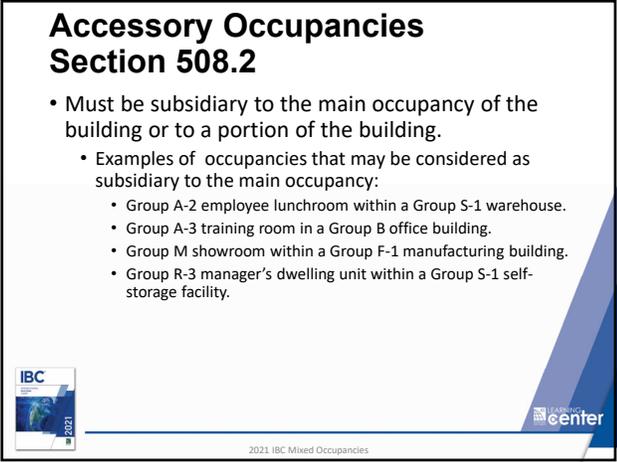
93



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Accessory Occupancies: Occupancy Classification – Section 508.2.1

- Must be assigned to an occupancy group established in Chapter 3 based on unique characteristics.
- The spaces of the building considered as accessory occupancies must meet all code requirements applicable to the specific to the accessory occupancy classification, not that of the main occupancy, including:
 - Means of egress requirements.
 - Fire protection requirements.

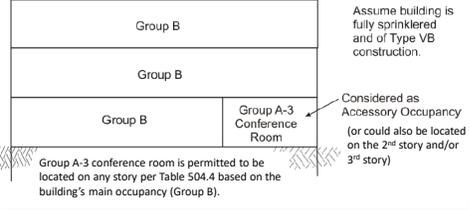



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Accessory Occupancies: Allowable Building Height - Section 508.2.2

- Allowable number of stories limited to that set forth in Section 504 for the main occupancy.



Assume building is fully sprinklered and of Type VB construction.

Considered as Accessory Occupancy (or could also be located on the 2nd story and/or 3rd story)

Group A-3 conference room is permitted to be located on any story per Table 504.4 based on the building's main occupancy (Group B).




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Accessory Occupancies: Allowable Building Area - Section 508.2.3

- Allowable area of building is based on the main occupancy.
- Combined area of the main occupancy and accessory occupancy cannot exceed that permitted by Section 503.1 for the main occupancy.




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Accessory Occupancies: Allowable Building Area-Section 508.2.3

Maximum floor area of building is based totally upon that of the Group B occupancy.

92,000	Table 506.2
5,750	Frontage increase
97,750	Total allowable area in square feet

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Accessory Occupancies: Allowable Building Area - Section 508.2.3

- Limited to 10 percent of the floor area of the story located.
 - When more than one accessory occupancy is under consideration, the aggregate area of such occupancies are used to determine compliance.
- Floor area cannot exceed the tabular values for nonsprinklered buildings established by Table 506.2 for each accessory occupancy.

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Accessory Occupancies Examples

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Accessory Occupancies: Separation - Section 508.2.4

- Application of the accessory occupancy option will result in no physical or fire-resistance-rated separation being mandated.

Regulated as Accessory Occupancy

Open

Group R-1 Hotel

Group A-2 Restaurant

Group A-3 Meeting room

Physical separation but nonrated

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Accessory Occupancies: Section 508.2.4, Exceptions

- Group H-2, H-3, H-4 and H-5 occupancies to be separated from all other occupancies per Section 508.4 (separated occupancies).
- Group I-1, R-1, R-2 and R-3 dwelling units and sleeping units to be separated from each other and from accessory occupancies contiguous to them per Section 420.

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Accessory Occupancies: A Seven-Step Process

- Determine the various occupancy classifications that are found within the building.
- Verify that any occupancy group under consideration as an accessory occupancy is subsidiary to the major occupancy of the building.
- Verify that the floor area of the accessory occupancy does not exceed 10 percent of the floor area of the story in which it is located.

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**Accessory Occupancies:
A Seven-Step Process**

- Verify that the floor area of the accessory occupancy does not exceed the tabular values for nonsprinklered buildings set forth in Table 506.2 for the building's type of construction.
- Limit the building's floor area to the allowable floor area based on the allowable area for the main occupancy.




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**Accessory Occupancies:
A Seven-Step Process**

- Limit the maximum allowable height of the accessory occupancy based on Section 504 for the main occupancy.
- Apply all other code requirements to each portion of the building based on the individual occupancy classification of the space.




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**Accessory Occupancies:
Applying the Process**

- Given:** A four-story office building with a large meeting room (occupant load of 78) on the second floor. The building is fully sprinklered; is Type IIB construction and qualifies for a 75 percent frontage increase for allowable area. Each story of the building contains 45,000 square feet and the floor area of the meeting room is 1,170 square feet. It is intended that no fire-resistant occupancy separation be provided between the meeting room and the remainder of the building.




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Accessory Occupancies: Applying the Process

- **Determine:** Do the mixed-occupancy conditions comply with the requirements for accessory occupancies?

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Accessory Occupancies: Applying the Process

- **Solution:**
 1. Determine the various occupancy classifications that are found within the building.
Offices: Group B
Meeting Room: Group A-3
 2. Verify that any occupancy group under consideration as an accessory occupancy is subsidiary to the occupancy of the building.
The meeting room use is directly related to the function of the office environment.

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Accessory Occupancies: Applying the Process

3. Verify that the floor area of the accessory occupancy does not exceed 10 percent of the floor area of the story in which it is located.
Floor area of meeting room is 1,170 square feet, approximately 3 percent of the floor area of the 2nd story.

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Accessory Occupancies: Applying the Process

4. Verify that the floor area of the accessory occupancy does not exceed the tabular floor area (without area increases of Section 506) set forth in Table 503 for the building's type of construction.

Floor area of 1,170 square feet does not exceed tabular area of 9,500 square feet for Group A-3 in Type IIB construction




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Accessory Occupancies: Applying the Process

5. Limit the building's floor area to the allowable floor area based on the allowable area for the main occupancy.

Tabular area	69,000 sf	Based on all Group B
Frontage increase	17,250 sf	75% increase
Total per story	86,250 sf	
Total for building	258,000 sf	3x allowable/story




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Accessory Occupancies: Applying the Process

6. Limit the maximum allowable height of the accessory occupancy based on Section 504.

Group A-2 occupancy limited to 1st, 2nd and/or 3rd stories.

7. Apply all other code requirements to each portion of the building based on the individual occupancy classification of the space.

Means of egress, fire protection and other requirements based on individual occupancies.




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Practice Exercise

- **Given:** A 10,250-square-foot, single-story musical instrument manufacturing building with storage room and offices. The storage room is 700 square feet. The offices are 300 square feet. The building is not sprinklered, but has open frontage allowing 25-percent increase in allowable area. The building is of Type VB construction.

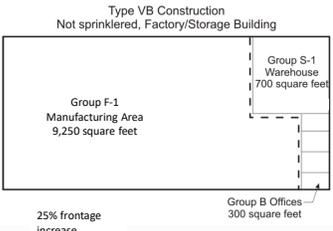



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Practice Exercise

- **Determine:** Do the mixed occupancy conditions comply with the requirements for accessory occupancies?



Type VB Construction
Not sprinklered, Factory/Storage Building

Group F-1
Manufacturing Area
9,250 square feet

Group S-1
Warehouse
700 square feet

Group B Offices
300 square feet

25% frontage increase




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Solution

Classification of occupancies	Groups: F-1 manufacturing S-2 storage B offices
Verify accessory occupancies are subsidiary to major occupancy.	Storage is used for holding materials used in the manufacturing process as well as the finished instruments. The offices are for managers, human resources staff, accounting and payroll staff.
Verify accessory occupancies do not exceed 10 percent of floor area.	Storage – 700 sq. ft. – Less than 10% Offices – 300 sq. ft. – Less than 10% Aggregate of accessory areas – 1,000 square feet Maximum allowed accessory area is 10% of 10,250 square feet = 1,025 square feet




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Solution

Verify accessory occupancies do not exceed tabular area per Table 506.2	Group B – 9,000 sq. ft. Group S-1 – 9,000 sq. ft.
Limit floor area to maximum allowable floor area of building based on main use	Main occupancy: Group F-1 Allowable area for Type VB building of Group F-1: 8,500 sq. ft. (Table 506.2) 25% increase for frontage: 2,125 sq. ft. Maximum allowable building area: 8,500 + 2,125 = 10,625 sq. ft.
Limit allowable height of accessory occupancies to that of Section 503	Allowed height for Type VB buildings: Group B – 2 stories Group S-1 – 1 story
Apply all other code provisions	As applicable.

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Allowable Height and Area for Multi-Story Buildings

Module 9

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Mixed Occupancies: Allowable Height for Multistory Buildings Section 504.2

- For nonseparated occupancies, the maximum allowable height of the building will be based on the most restrictive allowances for the occupancies under consideration.

Building height limited to most restrictive of occupancies involved

and entire building limited to most restrictive of occupancies involved

- For separated occupancies, an individual occupancy shall not be located higher than permitted by Tables 504.3 and 504.4

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Mixed Occupancies: Allowable Height for Multistory Buildings Section 506.2.2

- Where building is 3 stories or less in height, if each story complies, then the building complies.
- Where building is 4 or more stories in height, then each story must comply for allowable area and entire building must comply.
 - Sum of ratios for all stories above grade plane not to exceed 3.0.




2021 IBC Mixed Occupancies

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Multistory, Mixed-Occupancy Example Nonseparated Occupancies

- Given:** A fully sprinklered, four-story, Type IIA hotel containing a Group A-2 restaurant, Group A-3 meeting rooms and Group M retail stores. Inadequate frontage provides for no area increase.
- Determine:** Does the building comply with the allowable height and area provisions of Chapter 5 using the "nonseparated occupancies" method?

A-2 8,000 square feet	R-1 38,000 square feet	
R-1 46,000 square feet		
R-1 46,000 square feet		
A-3 24,000 square feet	R-1 8,000 square feet	M 14,000 square feet

Building to be no higher than allowed by Tables 504.3 and 504.4 based on the most restrictive occupancy

For 58.1 square foot = 0.0029 m².




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Multistory, Mixed-Occupancy Example Nonseparated Occupancies

Height Limitations:
 Groups A-2 and A-3 3+1 4 stories max.
 Groups R-1 and M 4+1 5 stories max.

- Acceptable as height of building limited to 4 stories does not exceed maximum allowable height of 4 stories based on Group A-2/A-3 as most restrictive occupancy.

Solution for Total Building Area:

- Each story limited to 46,500 sf based on Group A-2/A-3 as most restrictive occupancy.
 - Acceptable as actual area of each story is only 46,000 sf

Total building area limited to 3X allowable area per story.

- Does not comply as actual building area of 230,000 sf (5 X 46,000) exceeds allowable building area of 139,500 sf (3 X 46,500) based on Group A-2/A-3 as most restrictive occupancy

- Therefore, building does not comply.**




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Multistory, Mixed-Occupancy Example Separated Occupancies

- Given:** A fully sprinklered, four-story, Type IIA hotel containing a Group A-2 restaurant, Group A-3 meeting rooms and Group M retail stores. Inadequate frontage provides for no area increase.
- Determine:** Does the building comply with the allowable height and area provisions of Chapter 5 using the "separated occupancies" method?

A-2 8,000 square feet	R-1 38,000 square feet	Occupancy to be located no higher than allowed by Tables 504.3 and 504.4 for each individual occupancy
R-1 46,000 square feet		
R-1 46,000 square feet		Occupancy to be located no higher than allowed by Tables 504.3 and 504.4 for each individual occupancy
A-3 24,000 square feet	R-1 8,000 square feet	
M 14,000 square feet		

For SI: 1 square foot = 0.0929 m².

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Multistory, Mixed-Occupancy Example Separated Occupancies

Height Limitations:
 Groups A-2 and A-3 3+1 4 stories max.
 Groups R-1 and M 4+1 5 stories max.
 Height limits are not exceeded.

Solution for Total Building Area:

Actual Area per Occupancy			Allowable Area per Occupancy Based on Table 506.2		
A-2:	8,000 sf	Flr 4	A-2:	46,500 sf	
A-3:	24,000 sf	Flr 1	A-3:	46,500 sf	
M:	14,000 sf	Flr 1	M:	64,500 sf	
R-1:	8,000 sf	Flr 1	R-1:	72,000 sf	
	46,000 sf	Flr 2			
	46,000 sf	Flr 3			
	38,000 sf	Flr 4			

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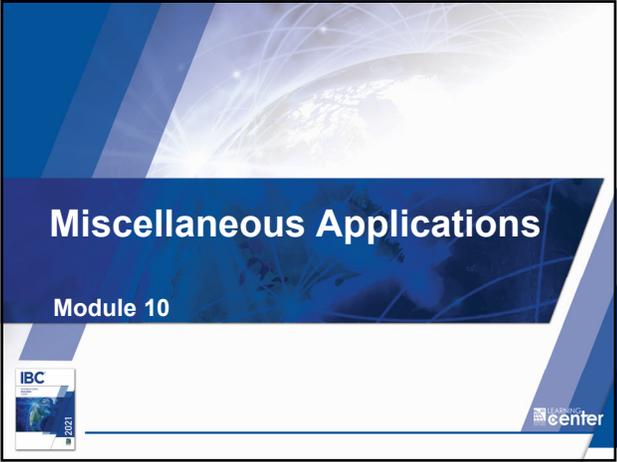
Multistory, Mixed-Occupancy Example Separated Occupancies

1st story $24,000/46,500 + 8,000/72,000 + 14,000/64,500 = 0.85$ OK
 2nd story $46,000/72,000 = 0.64$ OK
 3rd story $46,000/72,000 = 0.64$ OK
 4th story $8,000/46,500 + 38,000/72,000 = 0.70$ OK
 Aggregate for building $0.85 + 0.64 + 0.64 + 0.70 = 2.83 < 3$ OK

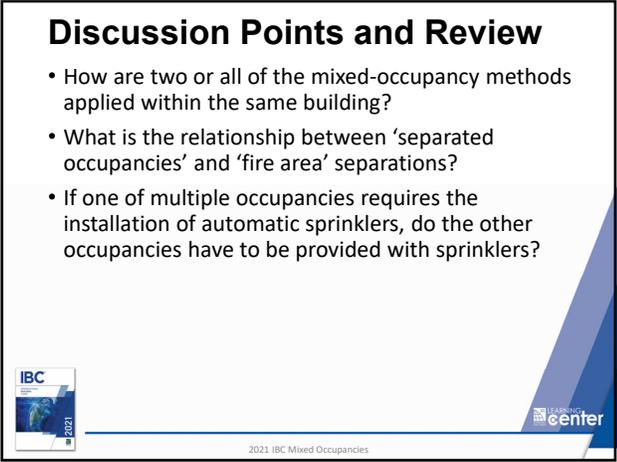
Note: Each floor is analyzed for compliance on a floor-by-floor basis, plus the building as a whole must also comply.

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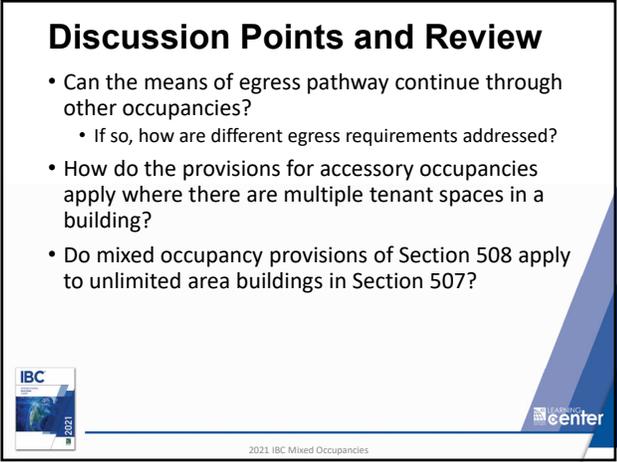
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Multiple Options Used in a Single Building – Section 508.1

- Section 508.1 allows four combinations:
 1. Accessory and nonseparated occupancies.
 2. Accessory and separated occupancies.
 3. Nonseparated and separated occupancies.
 4. All three options in the same building.
- Although the application of multiple methods is typically applied on a story-by-story basis, there is no limitation as to its application.




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Multiple Options Used in a Single Building – Section 508.1

- Assume fully-sprinklered, Type VB building as shown:



- Allowable Height per Table 504.4*:
 - A-2: limit of 2 stories
 - B: limit of 3 stories
 - M: limit of 2 stories
- Nonseparated Occupancies:
 - Limit of 2 stories due to A-2 or M
- Separated Occupancies:
 - Limited to 1st and 2nd story for A-2 and M
 - Group B permitted on all 3 stories

*Also regulated for allowable area and fire protection features




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Fire Areas vs. Occupancy Separations Section 901.7

- Although fire areas and ‘separated occupancy’ separations are similar in design and construction, they are two totally unrelated concepts.
 - Created through use of fire walls, fire barriers and/or horizontal assemblies.
 - Fire areas are typically limited to alternative approach to automatic sprinkler system requirements.
 - Occupancy separations address dissimilar occupancies.
 - Where two occupancies are separated under the separated occupancies method of Section 508.4, fire areas may not necessarily be created in regard to the provisions of Chapter 9.




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Fire Areas Section 901.7

- Fire-resistance rating of fire barriers creating fire areas based on Table 707.3.10.
- Fire-resistance rating of fire barriers used to separate occupancies based on Table 508.4.
- Where both conditions occur, the higher of the two required fire-resistance ratings to be applied.
- For example, where Table 707.3.10 requires greater fire-resistance than Table 508.4, complying with Table 508.4 will not establish separate fire areas.




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Fire Areas Section 901.7

No sprinkler system

B 8,000 sq. ft.	F-1 10,000 sq. ft.
--------------------	-----------------------

Minimum 3-hour fire barrier required

No sprinkler system

S-1 10,000 sq. ft.	A-3 3,000 sq. ft.
-----------------------	----------------------

Minimum 3-hour fire barrier required

For SI: 1 square foot = 0.0929 m².

- Occupancy separation not required per separated occupancies and Table 508.4.
- Fire area separation of 3 hours required by Section 903.2.4 and Table 707.3.10.
- Occupancy separation of 2 hours required per separated occupancies and Table 508.4.
- Fire area separation of 3 hours required by Sections 903.2.1.3 and 903.2.9 and Table 707.3.10.




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Means of Egress Chapter 10

- Can the means of egress (MOE) path for one occupancy travel through other occupancies in the building?
 - Yes, Section 1016.2 anticipates this to a great extent.
- Where the MOE path travels from one occupancy to another, which occupancy's egress requirements prevail?
 - The requirements for both occupancies should be applied, which typically results in the application of the most stringent provisions for that portion of the egress path.

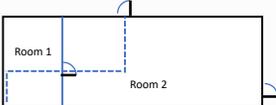



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Means of Egress Chapter 10

- How are maximum travel distance and common path of egress travel determined where travel occurs through multiple occupancies?



- Unity formula (sum of the ratios) is established in Section 1006.3.4.1 as appropriate method for establishing single-exit stories.

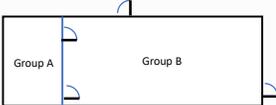
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Means of Egress Chapter 10

- How is requirement for panic hardware applied where travel occurs through multiple occupancies?



- Section 1010.2.9 indicates panic hardware required on swinging doors 'serving' rooms or spaces with an occupant load of 50 or more in a Group A or E occupancy

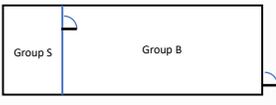
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Means of Egress Chapter 10

- How is requirement for two means of egress based on occupant load applied where multiple occupancies are present?



- Unity formula (sum of the ratios) is established in Section 1006.3.4.1 as appropriate method for establishing single-exit stories.

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Accessory Occupancies and Tenant Spaces

- Accessory occupancy provisions to be applied on a tenant-by-tenant basis.
- Although Section 508.2.3 states floor area limit based on 10% of floor area of the story, the guiding provision (Section 508.2) requires the accessory occupancy to be ancillary to the main occupancy of the building, or portion thereof.



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Unlimited Area Buildings (UAB) Section 507

- Unlimited area buildings permitted under the provisions of Section 507 may contain the occupancies and configurations specified in Sections 507.1 through 507.12.
 - Other occupancies are permitted in unlimited area buildings when in compliance with the provisions of Section 508.2 (Accessory Occupancies).
- Any or all of the mixed occupancy methods are permitted subject to the limitations of Section 508.
 - Nonseparated occupancies method would most typically be applied.



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Practice Exercise

- **Given:** A fully-sprinklered, five-story hotel of Type IIA construction contains the following occupancies located as shown:
- **First story:** Lobby (Group A-3), Restaurant (Group A-2), Administrative offices (Group B), Retail sales tenants (Group M) and Hotel guest rooms (Group R-1)
- **Second story:** Meeting/Conference rooms (Group A-3) and Hotel guest rooms (Group R-1)
- **Third and fifth stories:** Hotel guest rooms (Group R-1)
- **Fourth story:** Restaurant (Group A-3) and Hotel guest rooms (Group R-1)



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Practice Exercise

- The floor areas of each occupancy are as indicated. Other than a 1-hour fire-resistant separation of the hotel guest room portion, no fire-resistant separations are provided between occupancies on the first floor. Streets on two sides provide for a 25-percent frontage increase for allowable area.
- Determine:** Does the building below comply with the provisions of Section 508.1 regulating mixed-occupancy buildings?




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Type IIA Construction
Fully sprinklered NFPA 13

Group R-1 40,000 square feet				
Group A-2 6,000 square feet	Group R-1 34,000 square feet			
Group R-1 40,000 square feet				
Group A-3 24,000 square feet			Group R-1 16,000 square feet	
Group R-1 20,000 square feet	Group A-3 8,000 square feet	Group M 6,000 square feet	Group B 2,000 square feet	Group A-2 4,000 square feet

For SI: 1 square foot = 0.0929 m².




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Solution

Nonseparated Occupancies	This method may not be used for the entire building as Group A-2 limits building height to four stories. It may be utilized on the first story without applying to other stories.
Fire Protection	The building is fully sprinklered and has a fire alarm system in accordance with Section 907.2.8.
Allowable Height	Four-story limitation based on Group A-2 is not met for building.
Allowable Area	Groups A-2 and A-3 have the most restrictive allowance of 50,375 square feet (46,500 + 3,875). Since the aggregate building area of all stories is 200,000 square feet (40,000 times five stories) which exceeds the allowable building area of 151,125 square feet (3 X 50,375), the building is not in compliance for allowable area.

Building does not comply. Both the allowable height and allowable area provisions must be in compliance, and neither complies.




2021 IBC Mixed Occupancies

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Solution

Separated Occupancies	This method is used throughout the building except for the non-Group R-1 portion of the 1 st story (where the nonseparated occupancies method is applied).
Separation per Table 508.4	There is a minimum 1-hour fire-resistant separation required between the Group R-1 occupancy and all other occupancy groups. The required 1-hour separation is already provided horizontally due to the 1-hour floor construction required in a Type IIA building.
Allowable Height	Group R-1 occupancies are not permitted above the fifth story. Group A-2 and A-3 occupancies shall not be located above the fourth story.
Allowable Area	For allowable area purposes based on individual stories, the various occupancies on the first story, other than the Group R-1, will be evaluated under the nonseparated occupancies provisions of Section 508.3. Floor levels two through five, as well as the Group R-1 portions of the 1 st story, will be evaluated as separated occupancies in accordance with Section 508.4.




2021 IBC Mixed Occupancies

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Solution

Allowable Area per Occupancy (based on Table 506.2 and 25% frontage increase):

- A-2 50,375 square feet
- A-3: 50,375 square feet
- B: 121,875 square feet
- M: 69,875 square feet
- R-1: 78,000 square feet




2021 IBC Mixed Occupancies

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Solution

Allowable Area per Occupancy:

- 1st story*
 $20,000/50,375 + 20,000/78,000 = 0.66$ **OK**

*All portions of first story other than Group R-1 regulated as nonseparated occupancies, limited by allowable areas of Group A-2/A-3 occupancies. As a whole including the Group R-2 portion, first story then regulated as separated occupancies.




2021 IBC Mixed Occupancies

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Solution

Allowable Area per Occupancy:

- 2nd story
 $24,000/50,375 + 16,000/78,000 = 0.69$ **OK**
- 3rd story
 $40,000/78,000 = 0.51$ **OK**
- 4th story
 $6,000/50,375 + 34,000/78,000 = 0.56$ **OK**




2021 IBC Mixed Occupancies

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Solution

Allowable Area per Occupancy:

- 5th story
 $40,000/78,000 = 0.51$ **OK**
- All stories
 $0.66 + 0.69 + 0.51 + 0.56 + 0.51 = 2.93 \leq 3$ **OK**




2021 IBC Mixed Occupancies

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Final Reflection

This slide will help the learner to reflect on the day and what they will take back to the job and apply.

- **What?** What happened and what was observed in the training?
- **So what?** What did you learn and what difference did this training make?
- **Now what?** How will you do things differently back on the job as a result of this training?




2021 IBC Mixed Occupancies

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